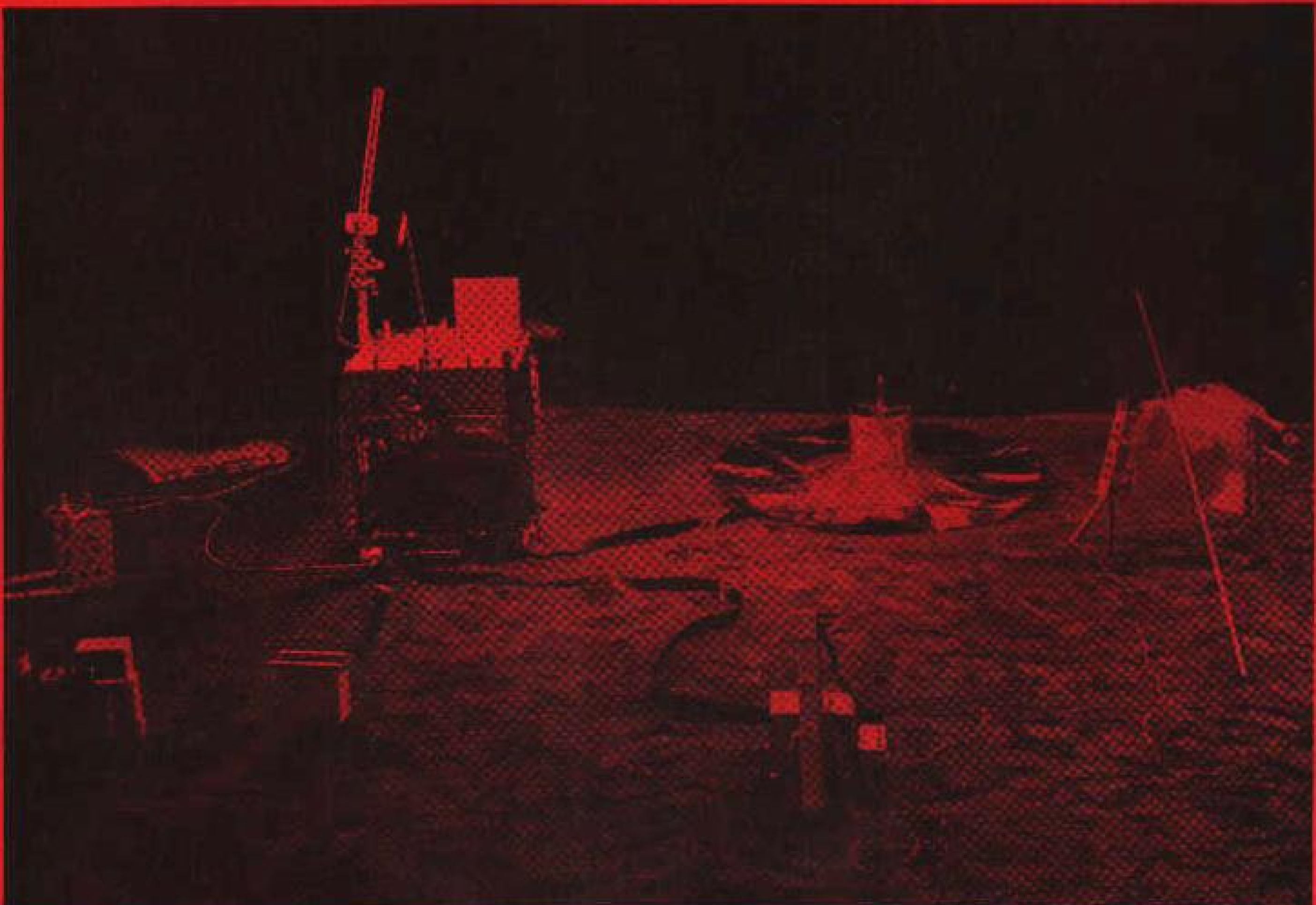
Apollo 13-
The Second
ALSEP

Apollo
Lunar
Surface
Experiments
Package



Bendix Aerospace Systems Division

Apollo 13 - The Second ALSEP

First the Early Apollo Scientific Experiments Package (Apollo 11)

Then the first Apollo Lunar Surface Experiments Package (Apollo 12)

Now the second ALSEP (Apollo 13)

The short history of lunar scientific exploration has been a notable success. Few scientific field trips on earth can match it for the consistency and quantity of reliable data provided from the very first moment of activating the instruments. Over one billion scientific and engineering measurements of lunar surface phenomena have been recorded on earth from the sensors of the Early Apollo Scientific Experiments Package and the first ALSEP. Now the third Apollo team to the lunar surface will establish a scientific base at a new site (Frau Mauro) through the deployment of another ALSEP.

The second ALSEP is the next in a series of scientific exploration packages produced by Bendix Aerospace Systems Division for deployment at each of the different Apollo lunar landing sites. The objectives of ALSEP on this mission are:

- operation of a second passive seismic sensor identical to that operating on the Apollo 12 ALSEP so that data from different regions can be correlated.
- detection of minute pressures or variations in pressure which might be indicative of a lunar atmosphere.
- identification of quantities and energy levels of charged particles reaching the lunar surface within a spectrum much broader than that sensed on previous missions.
- measurement of the thermal conductivity of the lunar surface and the heat flow during lunation cycles.

These objectives will be met with an instrument system comprising a Bendix-designed Central Station similar to that used on previous missions and a group of four experiments:

- Passive Seismic Experiment - 4 seismic elements
- Lunar Atmosphere Experiment - 1 cold cathode ion gauge
- Charged Particle Lunar Environment Experiment - 2 charged particle physical analyzers
- Heat Flow Experiment - 2 sensitive temperature probes imbedded in specially drilled 10-foot holes in the lunar top soil.

These sensors are selected from the group of scientific instruments that have been especially developed for lunar surface exploration. The data provided by this multi-sensor system will be analyzed and interpreted under the guidance of NASA scientists and Principal Investigators.

ALSEP will be carried by an Apollo 13 astronaut (Figure 1) to a location west of the Lunar Module and deployed as shown in Figure 2. The ALSEP equipment items are depicted in Figure 3.

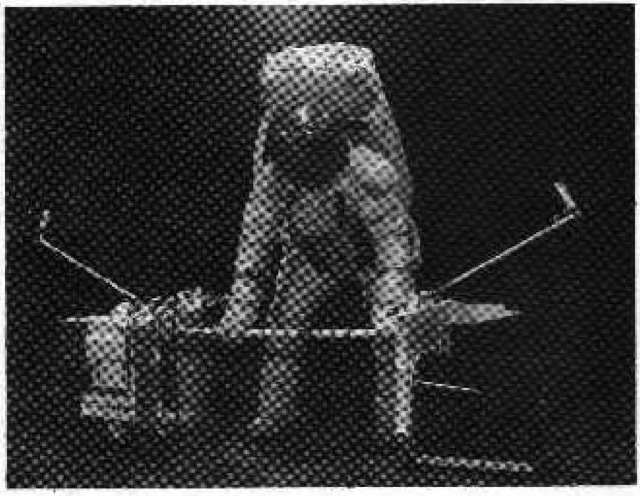


Figure 1 Astronaut Lifting ALSEP in Barbell Carry Mode

The four experiments that comprise the second ALSEP will be linked to the Central Station by heat-resistant ribbons of wire. Designed and built by Bendix Aerospace, the Central Station is ALSEP's communication center. It contains the receiver, data processor, transmitter and power management controls for the experiments. The source of power will be a radioisotope thermoelectric generator (RTG), the SNAP-27 built by General Electric. This is the same power source that performed so reliably on the first ALSEP.

The prime contractual responsibility for all the experiments on this package, with the exception of the Lunar Atmosphere Experiment, was awarded to Bendix Aerospace. A more detailed description of the Apollo 13 ALSEP experiments may be found on the following pages.

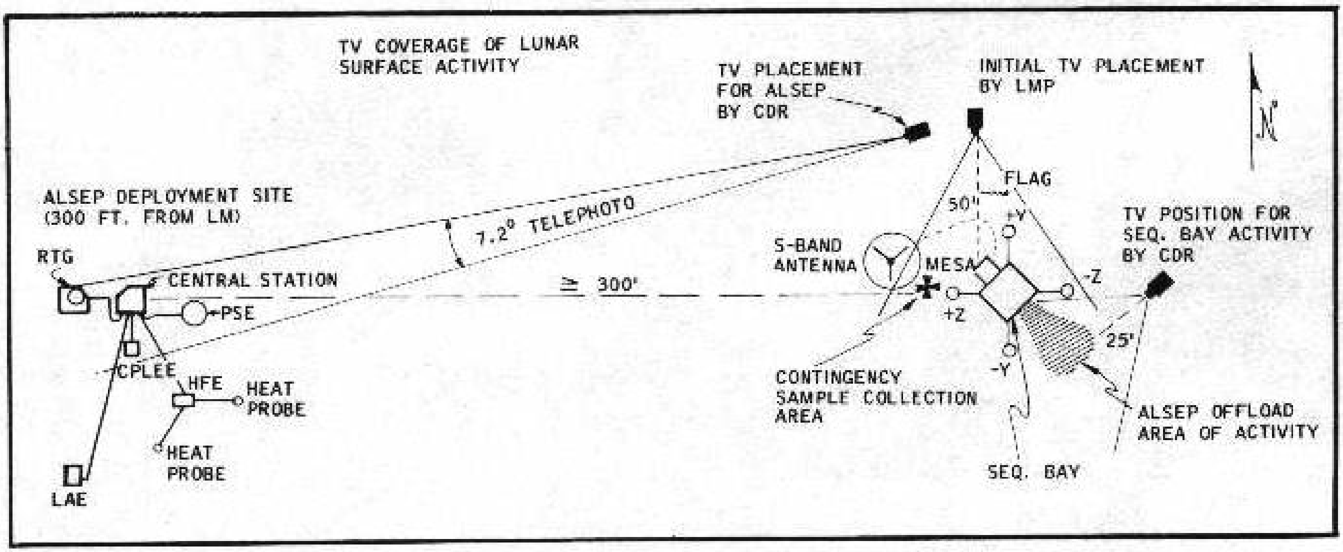


Figure 2 ALSEP Deployment Position

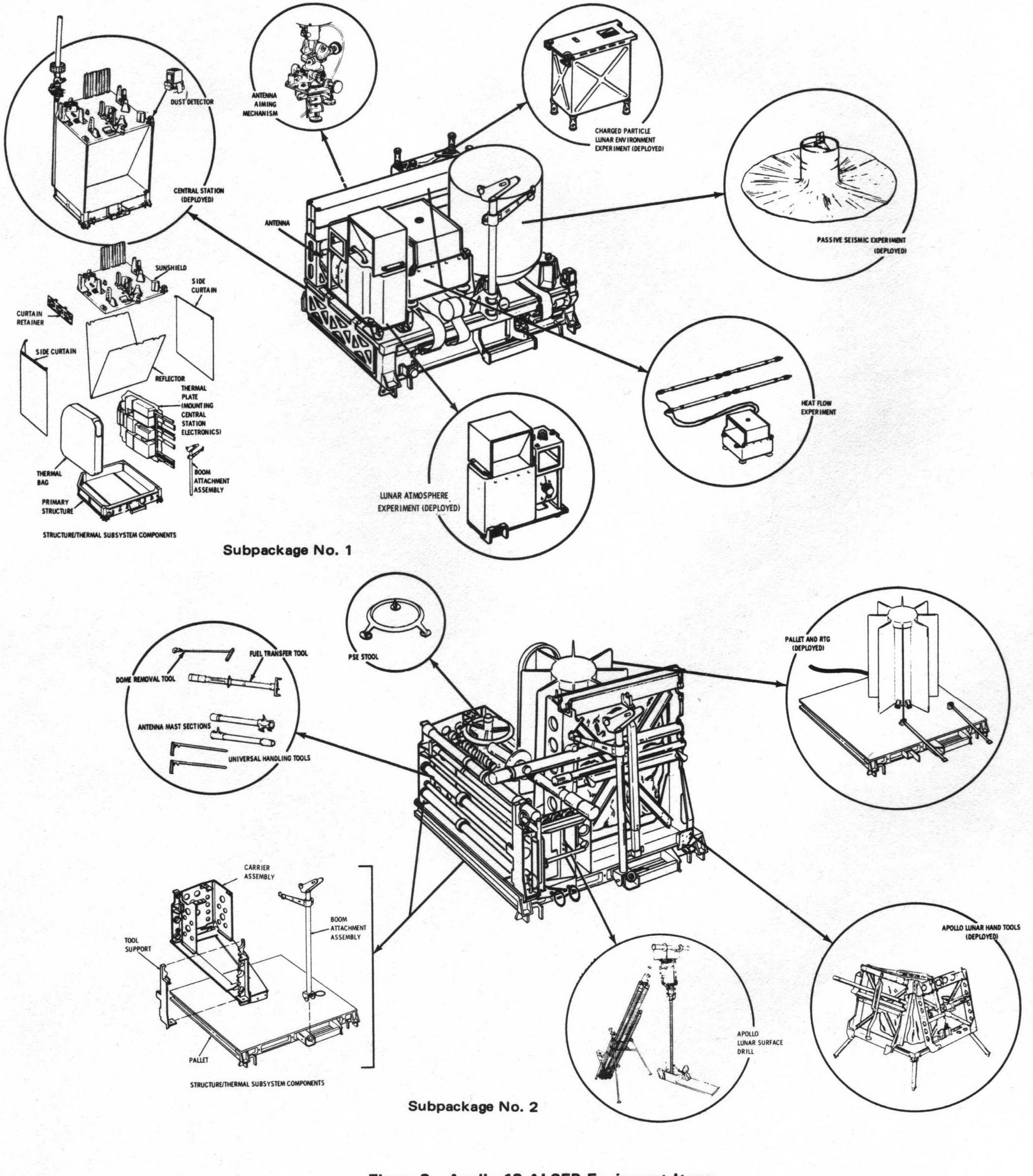
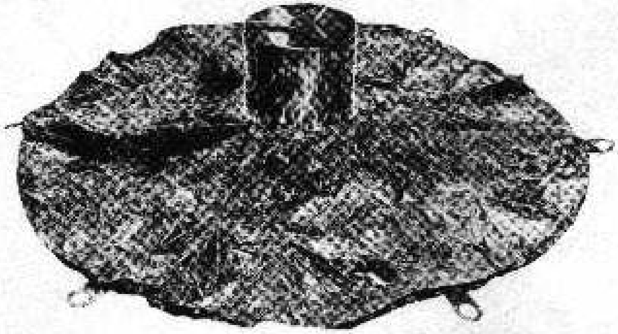


Figure 3 Apollo 13 ALSEP Equipment Items

PASSIVE SEISMIC EXPERIMENT



Our understanding of the composition of the interior of the earth comes in part from monitoring earthquakes. The motion produces vibrations which, as they travel through various types of rock, have speeds which are characteristic of the rock through which they traveled.

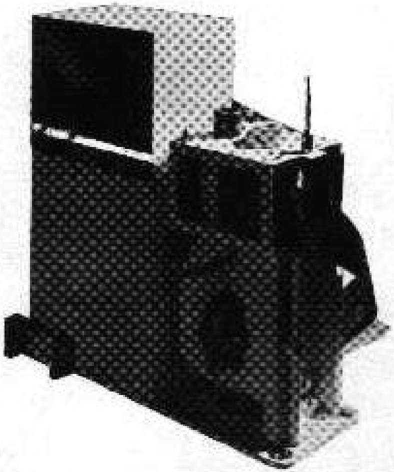
By correlating information from a network of seismometers placed at different locations on the lunar surface, the origin of seismic signals will become more clear.

Information about the structure of the moon may help to answer the question of its origin; whether it is part of the same mass from which the earth was formed, or whether it is wholly unlike the earth, a captured piece of the cosmos. This in turn will help indicate the origin of the earth and the solar system.

The seismometer measures by recording the motion between two weights. One weight, the body of the instrument, encloses a second weight which is suspended on a very flexible hinge. The seismometer will move with the ground while the suspended weight inside it tends to remain immobile. Four sensors of this type are contained in each unit placed on the moon for measuring in different directions and frequencies.

The sensitivity of this device is such that, on Apollo 11, it reported astronaut footsteps and their movements inside the Lunar Module.

The Principal Investigator for the Passive Seismic Experiment is Dr. Gary Latham of Lamont Geological Observatory.



LUNAR ATMOSPHERE EXPERIMENT

That the moon has practically no atmosphere can be verified with an inexpensive telescope. One watches whether or not the light from a star dims just before it passes behind the moon. To say that the moon has no atmosphere at all, however, is to say that there are absolutely no particles of any kind near its surface, and that is an unlikely case.

While the atmosphere will be very slight, it may carry traces of volcanic gasses, which would tell a great deal, indeed, about the moon. Moreover, when astronauts land on the moon they contribute a significant percentage of new atmosphere to the lunar environment by the gasses they and the Lunar Module produce. The rate at which this "foreign" atmosphere is lost from the moon is of scientific interest.

A lunar atmosphere detector is carried on each Apollo lunar landing. On Apollo 13, it will be a separate experiment; on Apollo 12 it was joined to the Lunar Ionosphere Detector.

In order to detect an atmosphere with particles having no electrical charge, the atmosphere must be ionized. This is accomplished by accelerating free ions within the detector. The charged particles entering the sensor are accelerated by a strong electric field (4500 volts) and collide with the neutral atoms of the lunar atmosphere. The collision causes the neutral atoms to become electrically charged; measuring this charge gives a measure of the lunar atmosphere.

The Principal Investigator for the Lunar Atmosphere Experiment is Dr. Francis Johnson of the Southwest Center for Advanced Studies.

CHARGED PARTICLE LUNAR ENVIRONMENT EXPERIMENT

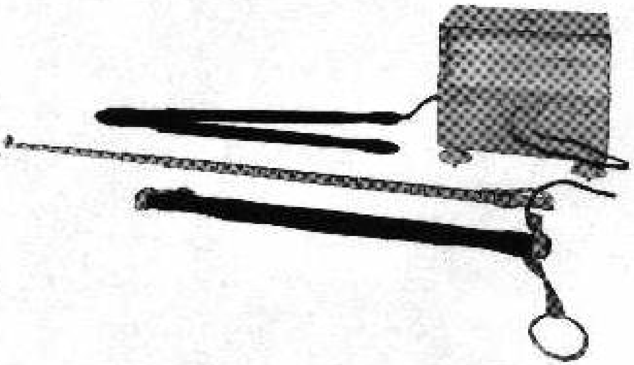
The absence of a significant atmosphere and magnetic field on the moon will allow scientists to use it as a large laboratory to study the electrically charged particles which inhabit outer space. These particles, which are parts of atoms, will have a wide range of speeds and energies. They will have either positive or negative charges and will behave according to whatever electric and magnetic fields there are around the moon.

Observing these particles and noting what happens to them near the moon will give new basic information about the forces which control the physical world.

The Charged Particle Lunar Environment Experiment will measure the energy and direction of particles and record changes in their direction.

The charged particle experiment uses a patented Bendix device, the Channeltron® electron multiplier. This is a small tube which can multiply electrons up to one million times. Each electron which enters the multiplier causes a much larger electron flow out of the tube. The charged particle experiment uses two analyzers containing arrays of electron multipliers to detect particles which have passed through an electronic sorting process. This sorting process consists of passing the particles past two plates which are electrically charged. The charges on the plates deflect the electrons according to their charge and velocity. By measuring the particles over various selected energy ranges, scientists will be able to understand better the types of charged particles found in outer space.

The Principal Investigator for the Charged Particle Lunar Environment Experiment is Dr. Brian J. O'Brien of Rice University.



HEAT FLOW EXPERIMENT

Whether or not the moon has a molten core as the earth is a very important question. Not only would a molten core indicate similar origin and development of the moon and the earth, but a molten core would indicate that volcanic activity could have caused many of the moon's surface features. If the moon does not have a hot center, it may literally be nothing more than a big rock, formed elsewhere in the cosmos and captured by the earth's gravity.

A measure of the internal heat of the moon and how that heat dissipates through the moon will indicate not only the history of the moon, but its composition as well.

The Heat Flow Experiment will detect whether or not there is a heat flow through the moon which is similar to that of the earth. On the earth, heat flow is relatively uniform, except in certain regions such as the mid-Atlantic rift.

The technique of the heat flow experiment is simple; two ten-foot holes are drilled in the moon and a combination of heater/thermometer probes is inserted into each hole. Each probe carries several heaters and thermometers. The thermometers measure thermal gradients with accuracies to 0.005°F. Measurements are made along each probe and between probes. Both temperature difference and heat conductivity will be measured.

Because little is known of the thermal properties of the moon, the Heat Flow Experiment will be able to measure subsurface temperatures over the range -300°F to +170°F.

The Principal Investigator for the Heat Flow Experiment is Dr. Marcus G. Langseth of Columbia University.

Apollo 13 ALSEP
Vital Statistics

Passive Seismic Sensor

Weight: 21 pounds

Normal Operating Power: 8.5 watts

Heat Flow Experiment

Weight: 10 pounds

Normal Operating Power: 8.8 watts

Cold Cathode Ion Gauge

Weight: 13 pounds

Normal Operating Power: 6.5 watts

Charged Particle Lunar Environment Experiment

Weight: 6 pounds

Normal Operating Power: 5.0 watts

Major Subcontractors:

Earth Sciences, A Teledyne Company; Arthur D. Little, Inc.; Gulton Industries, Inc., Data Systems Division; The Bendix Corporation, Research Laboratories